

BLOCK STRUCTURE AS A PART OF BLOCK INSTRUMENTATION

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OBJECTIVE

- ✗ Theory of the Neutrino
- ✗ NOvA Experiment
- ✗ Block Structure Project

WHAT IS A NEUTRINO ?

Three Generations of Matter (Fermions)				
	I	II	III	
mass→	2.4 MeV	1.27 GeV	171.2 GeV	0
charge→	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0
spin→	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
name→	u up	c charm	t top	γ photon
Quarks	4.8 MeV	164 MeV	4.2 GeV	0
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	0
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
	d down	s strange	b bottom	g gluon
Leptons	<2.2 eV	<0.17 MeV	<15.5 MeV	91.2 GeV
	0	0	0	0
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	Z ⁰ weak force
	0.511 MeV	105.7 MeV	1.777 GeV	80.4 GeV
	-1	-1	-1	± 1
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
	e electron	μ muon	τ tau	W ⁺ weak force

Source: Fermilab's(NOVa) web server

There are three flavors of neutrinos:



We can consider a neutrino to act as an electrons with no charge

Muon neutrinos are elementary particles and have no net electric charge

Electron neutrino also known as lepton is a stable elementary particle in the lepton family.

Source: nocenslupus web server

DO NEUTRINOS HAVE MASS ?

Neutrinos oscillate so they must have mass!

Scientists don't know how much they weigh, which is heaviest, or by what process neutrinos get their mass.

This would help scientists to understand characteristics of the neutrino, including whether or not neutrinos are their own antiparticles.

WHY STUDY NEUTRINOS?

- ✖ Scientist have observed muon neutrinos oscillate into tau neutrinos.
- ✖ Scientist have also observed muon neutrinos oscillating into electron neutrinos but NOvA will make a more precise measurement.
- ✖ Possibly discover the order of neutrino masses: Which one is the heaviest? Which is the lightest?
- ✖ Discover the symmetry between matter and antimatter

Neutrino

Neutrino



Antineutrino



Source: Jefferson Lab's web server

WHAT IS THE NOVA NEUTRINO EXPERIMENT?

NOvA is a unique experiment that is intended to seek the qualities and attributes of Neutrinos and their behavior.

The NOvA neutrino experiment will study the properties of neutrinos starting in 2013.

Construction is scheduled to be complete in 2014, and the first run will last six years.

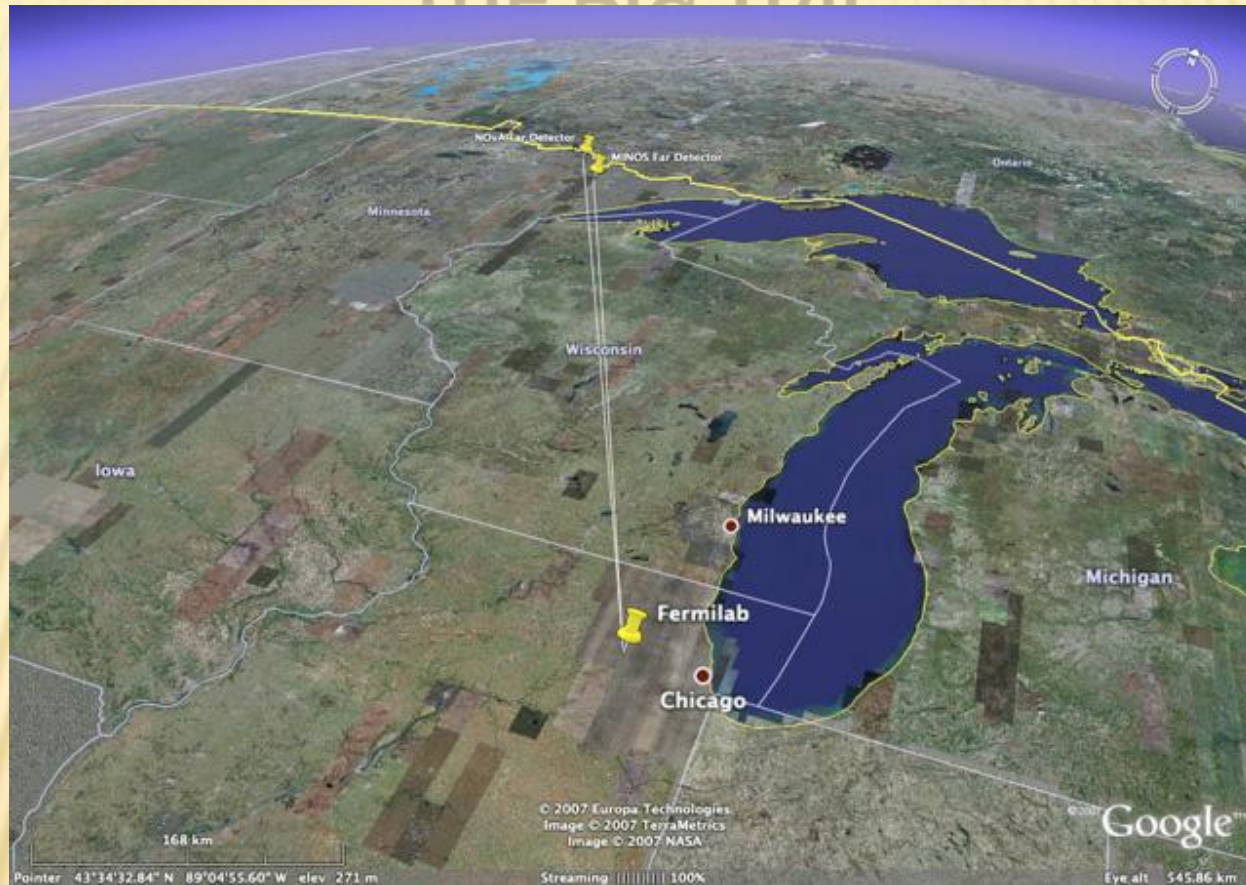
If the NOvA experiment can discover the actual weight order of the neutrinos it would eliminate theories that require a different weight order.

HOW DOES IT WORK?

- ✖ Neutrinos normally do not interact with other particles
- ✖ A beam of neutrinos will be generated from the NuMI neutrino beam
- ✖ The neutrinos will travel straight through the Earth since they rarely interact with other particles.
- ✖ Scientists will use statistics to determine if the muon neutrinos are oscillating into electron neutrinos.

HOW DOES IT WORK?

THE BIG TRIP



The NOvA experiment will generate a beam of neutrinos to send to a 15,000-ton detector(Far Detector) in Ash River, Minnesota. The particles will complete the 500-mile interstate trip in less than three milliseconds.

PLAYING MY PART

Block Structure as a part of the Block Instrumentation Group

A sub project of NOvA to characterize the definition of the detectors

Two Detectors (FHEP and Far Detector)were analyzed in this project to obtain structural data

Full Height Engineering Prototype (FHEP)

Important for the construction of the Far Detector



Source: Fermilab's (NOvA) web server

NEAR DETECTOR

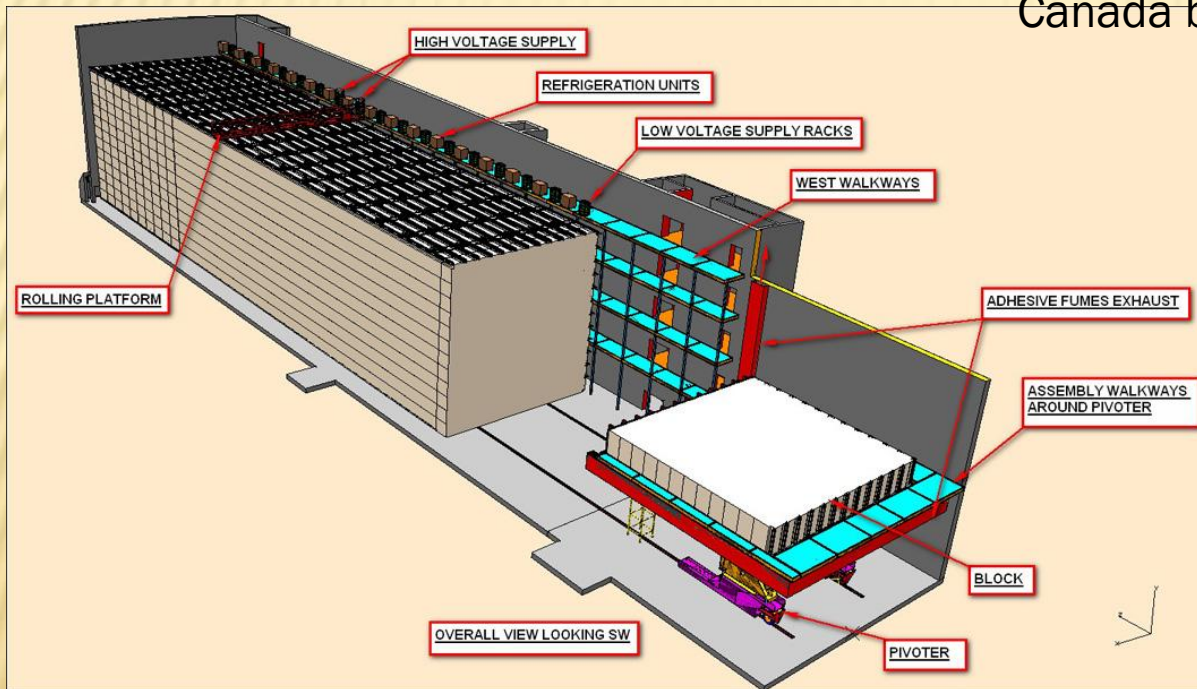


Source: Fermilab's (NOvA) web server

The Near Detector is a 222 metric-ton detector at Fermilab.

FAR DETECTOR

The Far Detector is a much larger detector measuring in at 15 metric-kiloton located in Minnesota just south of the U.S.-Canada border in (Ash River).



FAR DETECTOR

When a neutrino strikes an atom in the liquid scintillator, it releases a burst of charged particles.



SENSORS

✕ Distance Sensors

- + Help with the placement of the block
- + Measure the definition of the block
- + Help measure its swelling when the block is filled with oil

SYNOPTIC

Synoptic display shows real-time data from the Accelerator Control System at Fermilab.

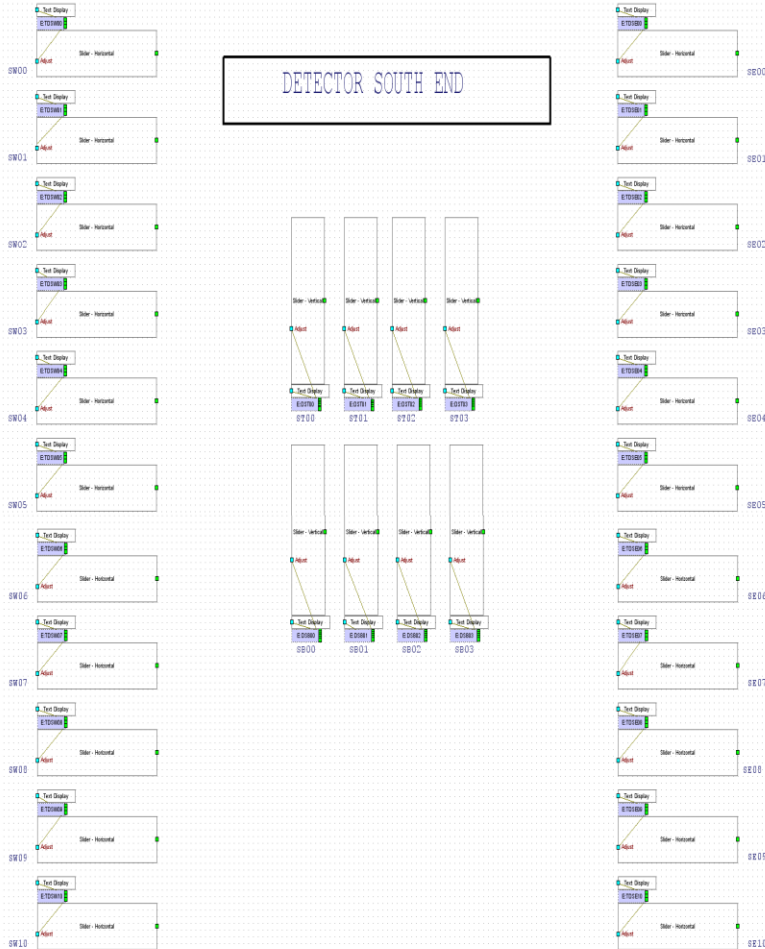
ACNET- Accelerator Control Network

GOALS OF THE PROJECT

- ✗ Create a display for the Prototype Detector (FHEP) to monitor its sensors
- ✗ Have the FHEP display be monitored in the control room
- ✗ Create a functioning display for the future Far Detector.
- ✗ Monitor and edit the FHEP displays daily to help create a well functioning Far Detector display
- ✗ Complete the Far Detector display before the first block goes up

BLOCK INSTRUMENTATION DISPLAY SOUTH TEST

DETECTOR SOUTH END



DETECTOR SOUTH END



ACNET CONSOLE

- ✖ Stores real time data
- ✖ Organizes the sensors by placement and name

```
H55
-<FTP>+ *SA+ X-A/D X=TIME SET D/A A/D Com-U ♦PTool♦
COMMAND ---- Log I= 0 Y=E:HTCVIG,E:HTCVIP,E:HTCPIG,E:HTCPIP
-< 6>+ 0ne+ 1_Hz F= 240 I= 1.0E-10, 1.0E-10, 1.0E-10, 1.0E-10
F= 1.0E-06, 1.0E-06, 1.0E-06, 1.0E-06
```

E:TDNB00	FHEP Distance NB00	1.6590811
E:TDNB07	FHEP Distance NB07	* 1.7855345
E:TDNE00	FHEP Distance NE00	* .47449902
E:TDNE11	FHEP Distance NE11	1.3558216
E:TDNT00	FHEP Distance NT00	1.5070326
E:TDNT07	FHEP Distance NT07	1.3120761
E:TDNW00	FHEP Distance NW00	1.0666865
E:TDNW11	FHEP Distance NW11	1.6275734
E:TDSB00	FHEP Distance SB00	1.6020461
E:TDSB03	FHEP Distance SB03	1.3494703
E:TDSE00	FHEP Distance SE00	1.2096176
E:TDSE10	FHEP Distance SE10	1.284157
E:TDST00	FHEP Distance ST00	1.6304759
E:TDST03	FHEP Distance ST03	1.321594
E:TDSW00	FHEP Distance SW00	1.6664238
E:TDSW10	FHEP Distance SW10	1.6041312

FHEP DISTANCE SENSOR ALARMS

✖ Distance Sensors

+ Limits For Alarms

✖ Distance: 1.05in.-1.7in.

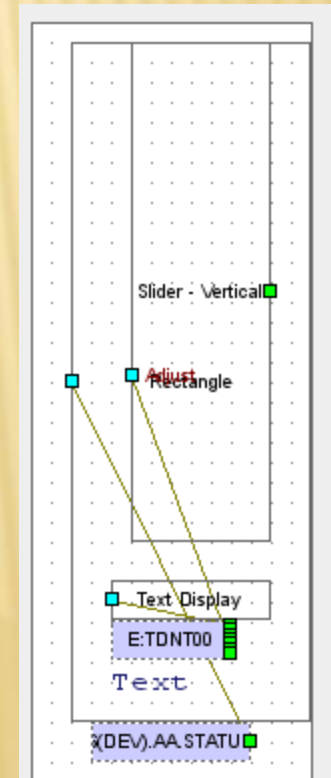
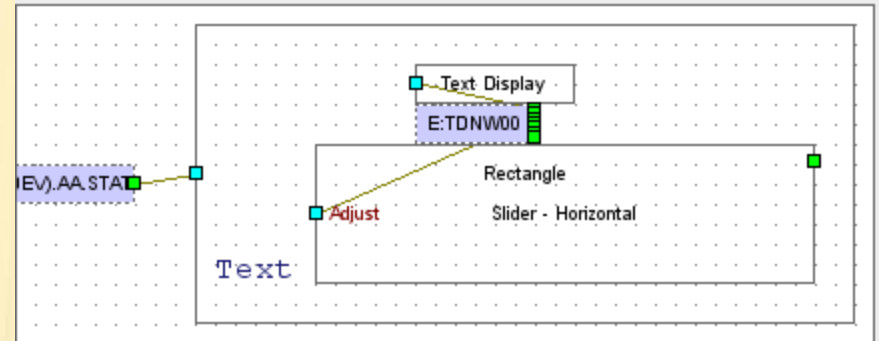
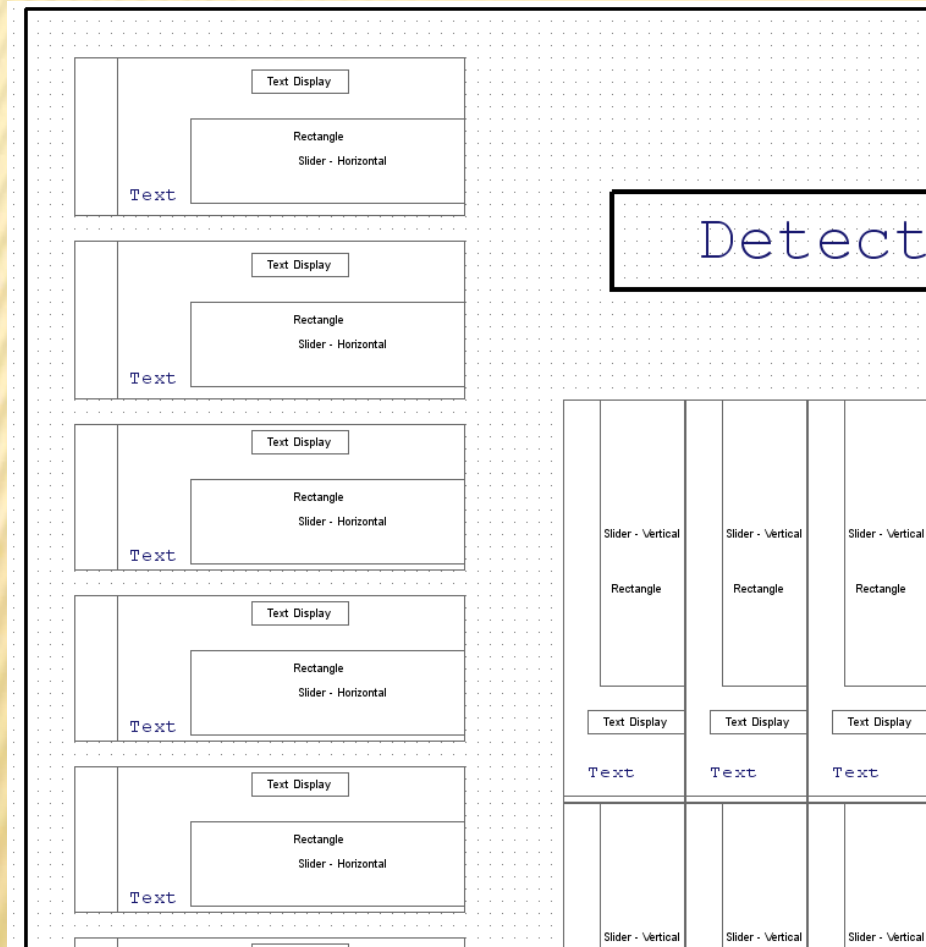
✖ Overview of Displays

+ South End

+ North End

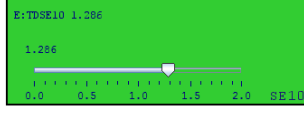
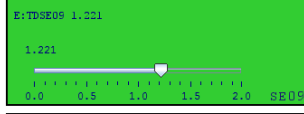
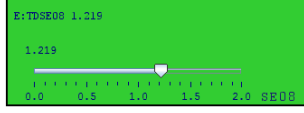
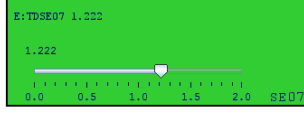
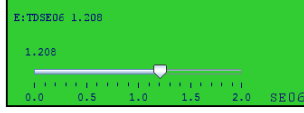
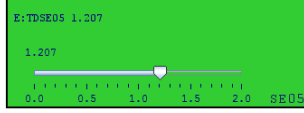
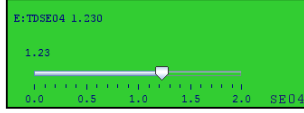
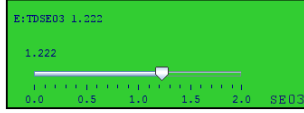
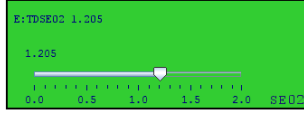
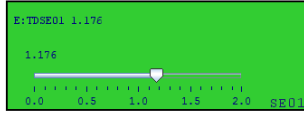
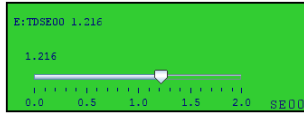
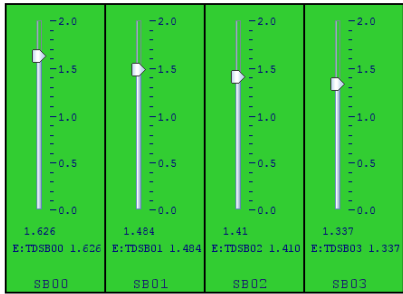
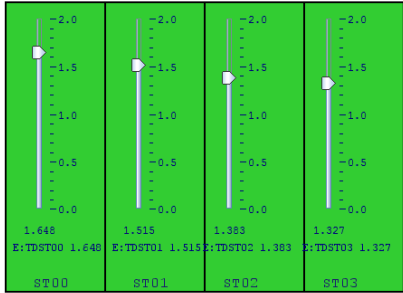
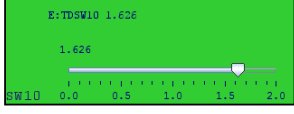
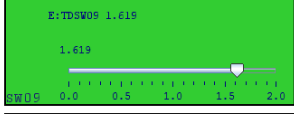
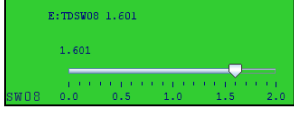
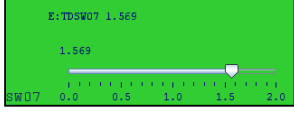
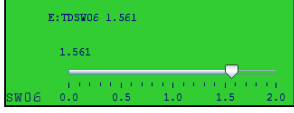
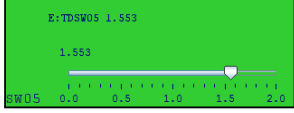
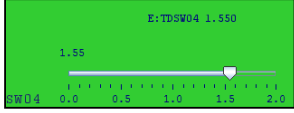
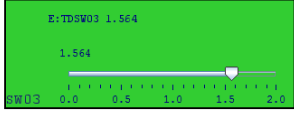
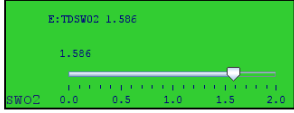
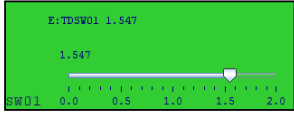
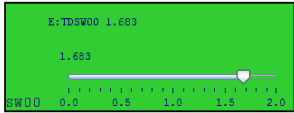


EMBEDDED DISPLAY

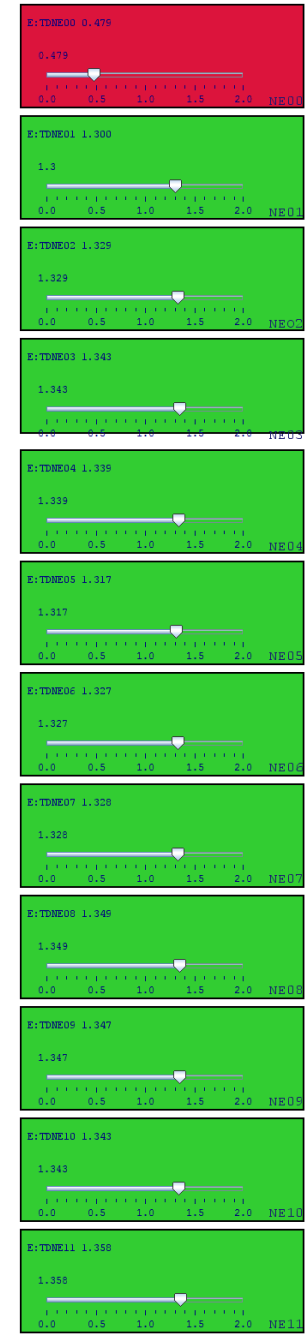
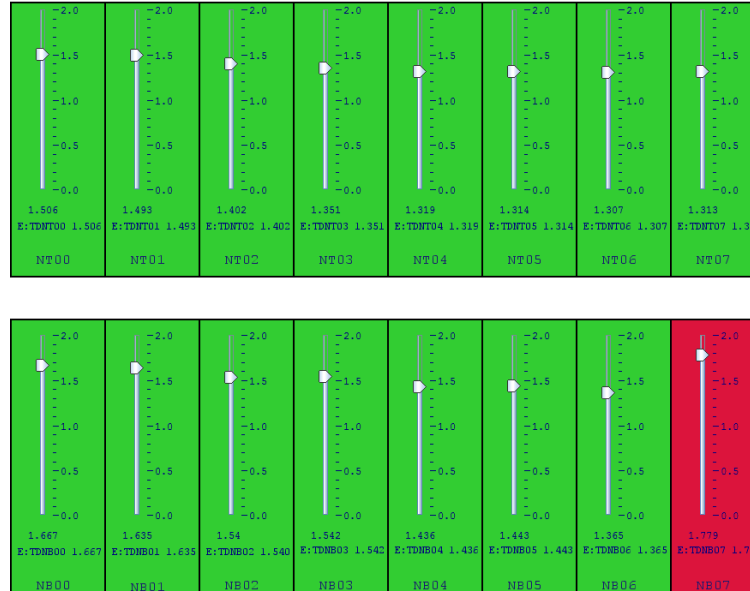
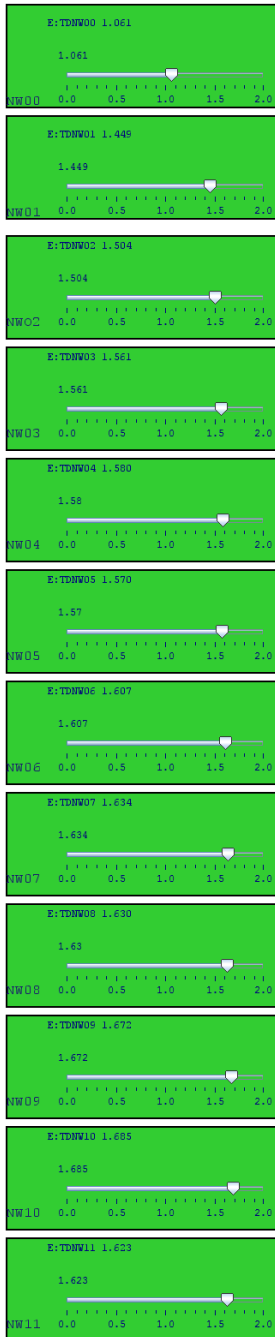


/Nova/distance_sensorH(DEV=E:TDNW01,LABEL=NW01)

DETECTOR SOUTH END



Detector North End



OVERVIEW OF FHEP



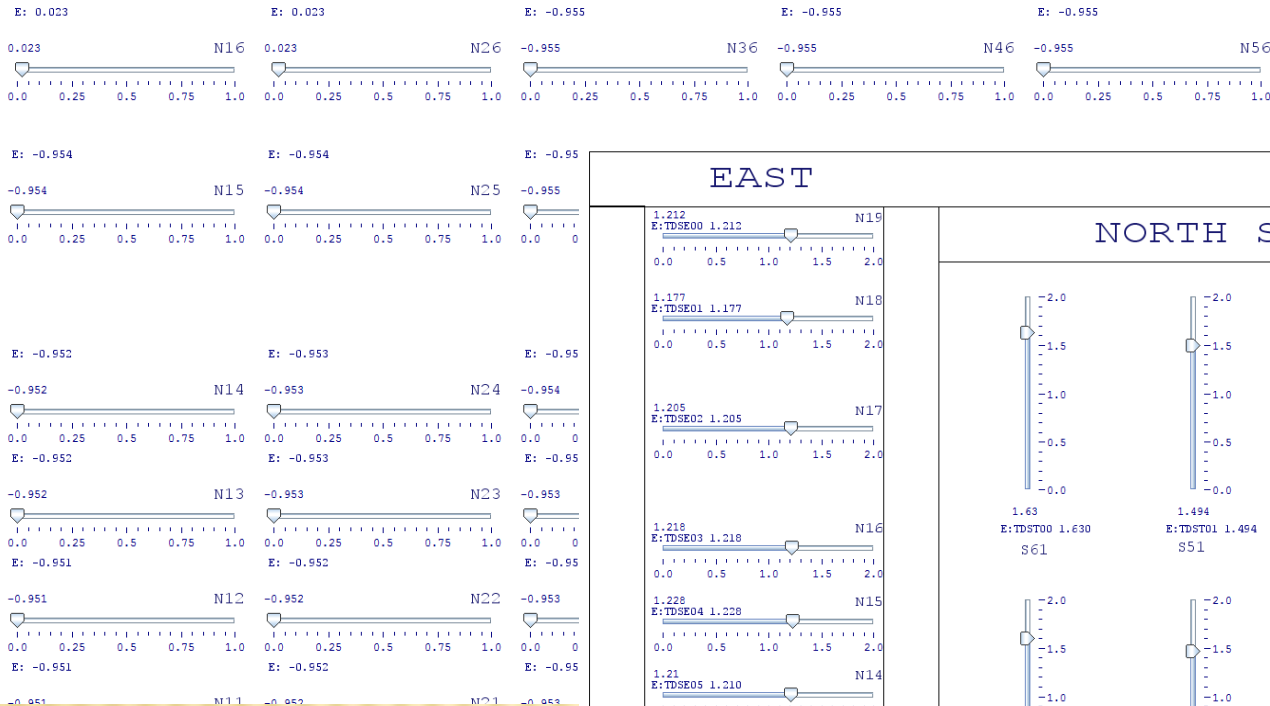
The Overview Display Can Be Found Below and Runs In The NOvA Control Room
<http://synoptic.fnal.gov/>

FHEP DISPLAY

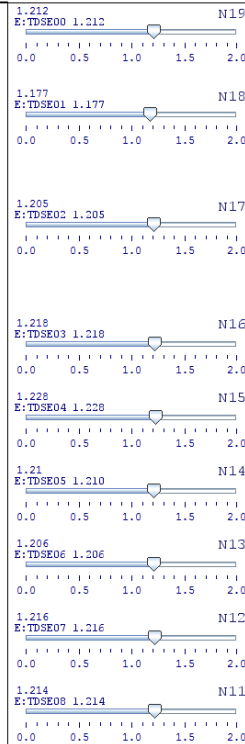
South Bookend	
Block 00	
Block 01	
Block 02	
Block 03	
Block 04	
Block 05	
Block 06	
Block 07	
Block 08	
Block 09	
Block 10	
Block 11	
Block 12	
Block 13	
Block 14	
Block 15	
Block 16	
Block 17	
Block 18	
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Block 22	
Block 23	
Block 24	
Block 25	
Block 26	
Block 27	
Block 28	

FAR DETECTOR DISPLAY

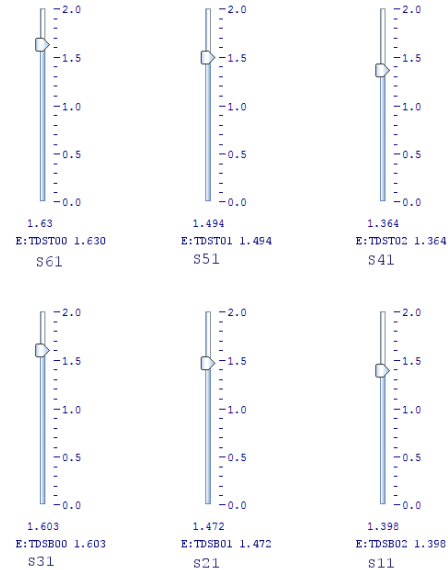
SENSOR LOCATIONS (SOUTH BOOKEND)



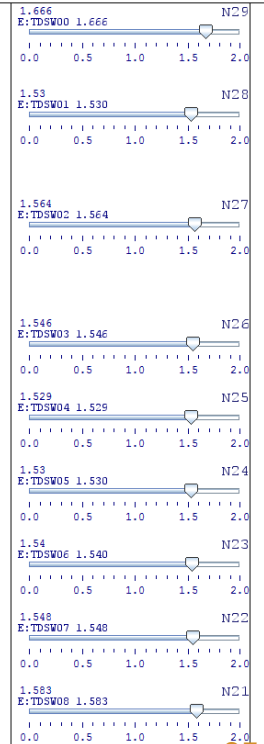
EAST



NORTH SIDE



WEST



RESULTS

- ✘ The events that were found after the displays were made were significant to the initial thoughts of the project.
- ✘ The display for the prototype was successful and helped to create the new display for the Far Detector
- ✘ The Far Detector is a total of 28 blocks and its display was successfully created using Synoptic which will run in the control room as soon as the first block goes up at Ash River.

CONCLUSION

- ✗ All goals were met with this project
- ✗ The FHEP display contributed much to the process of how we should analyze data for the Far Detector
- ✗ The Far Detector display is ready to be implemented at Ash River as soon as sensors are installed.
- ✗ Future research and work will continue on this project

MINNESOTA



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SIST Internship Committee

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Mrs. Linda M. Diepholz

Dr. Davenport

Fermi National Accelerator Laboratory

University of Virginia

NOvA Collaboration Group

Grambling State University

Southern University at Shreveport

Also To Anyone How Helped Contribute To This Experience

Questions or Concerns ?